

1.7.6 Seat Belts

NOTE

Before egress, the seat belt should be attached to the inboard handhold for accessibility upon ingress.

A seat belt is provided at each seat. The seat belts (figure 1-29) are constructed of nylon webbing. The belt end terminates in a hook which is secured to the outboard handhold. Belt length adjustment is provided by an adjustment buckle. A stretch section of the belt permits normal fastening and release.

1.7.7 Fenders

The deployable portion of each fender (figure 1-28) is positioned by the astronaut during LRV deployment on the lunar surface.

1.7.8 Toeholds

There are two toeholds, one on either side of the vehicle. The toehold is used to aid the crew in ingressing and egressing the LRV. The toehold is formed by dismantling the LRV/LM interface tripods and using the leg previously used as the tripod center member as the toehold. The tripod member is inserted into the chassis receptacle to form the operational position of the toehold.

NOTE

The toeholds are also used as tools to actuate the wheel-decoupling mechanism to release the telescoping tubes and saddle fitting on the forward chassis, and to free the steering decoupling rings from the stowed position. Either toehold may be used for decoupling.

1.7.9 Floor Panels

The floor panels in the crew station area are beaded aluminum panels (figure 1-30). The floor is structurally capable of supporting the full weight of standing astronauts in lunar gravity.

1G Trainer Note

The 1G Trainer floor panels are flat plates in lieu of beaded panels.

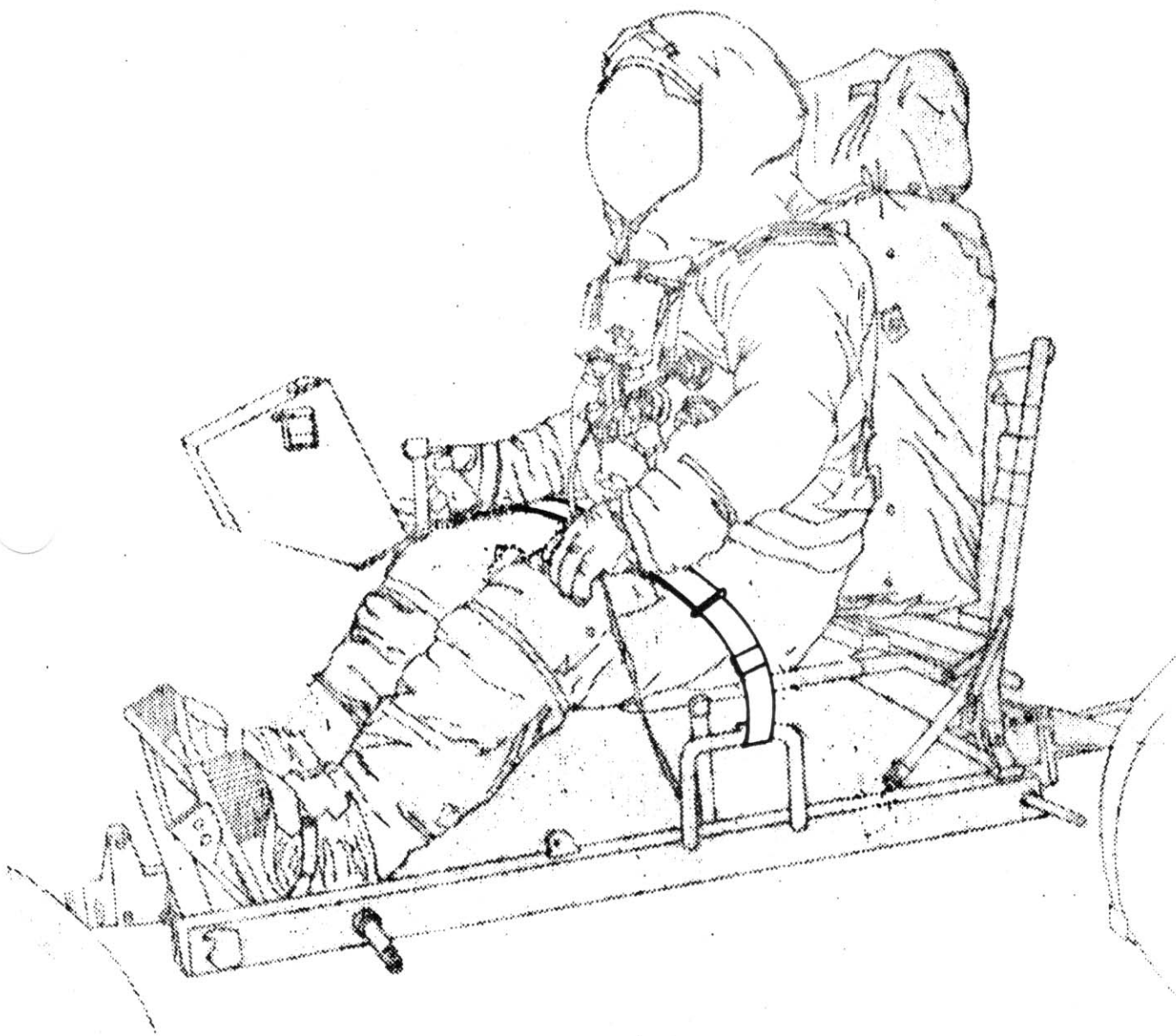
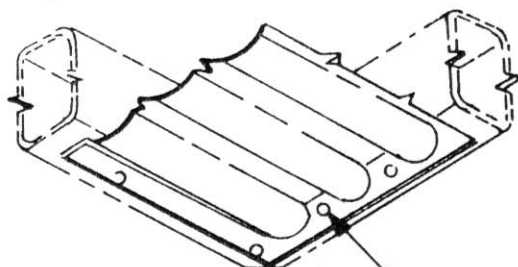
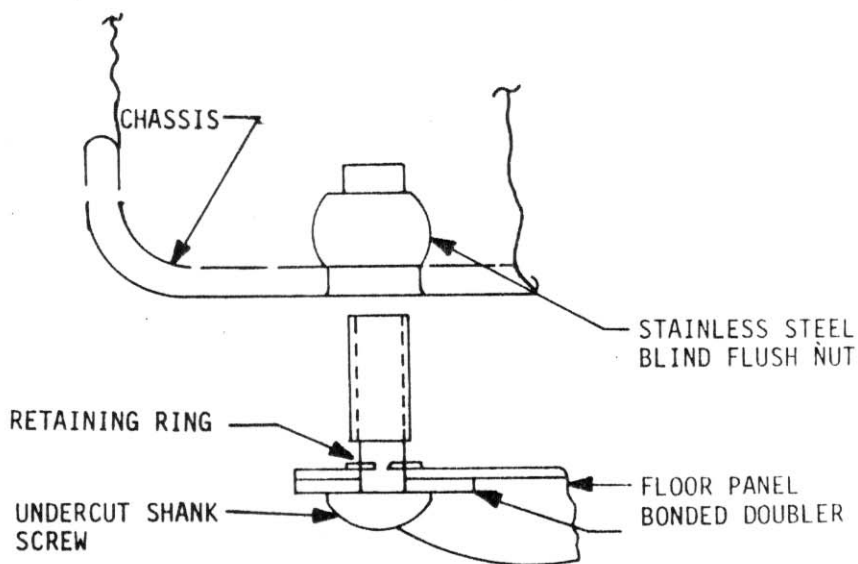
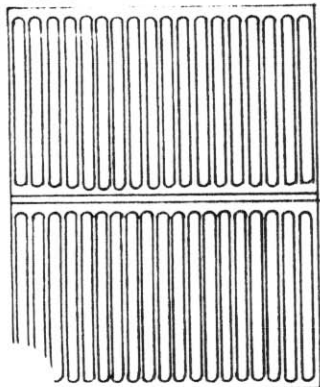


FIGURE 1-29 SEAT BELTS

CENTER CHASSIS
SECTIONS
.020 X 27.65 X 52.00



LOOKING FROM UNDERSIDE
OF VEHICLE

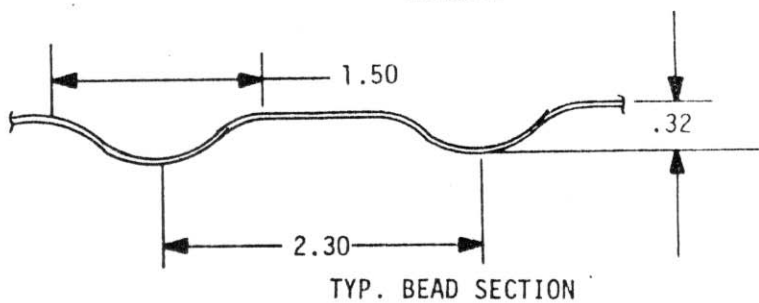


FIGURE 1-30 CREW STATION FLOOR PANELS

1.8 THERMAL CONTROL

1.8.1 LRV Thermal Control

Thermal control systems are incorporated into the LRV to maintain temperature sensitive components within the appropriate temperature limits during the translunar phase of a mission, during operation on the lunar surface, and during periods of inoperation on the lunar surface. Thermal control systems consist of special surface finishes, multilayer insulation, space radiators, second surface mirrors, thermal straps, and fusible mass heat sinks (figure 1-31).

1G Trainer Note

Thermal control for the 1G Trainer is described in paragraph 1.8.5.

1.8.2 Forward Chassis Thermal Control

The basic concept of thermal control for forward chassis components is energy storage during operation with subsequent energy transfer to deep space while the vehicle is parked between sorties. During operation heat energy released in the Drive Control Electronics (DCE) is stored in the DCE and the DCE thermal control unit (figure 1-32). Heat energy released in the Signal Processing Unit (SPU) is stored in the SPU, the SPU thermal control unit (a fusible mass device) and Battery No. 1. The SPU is thermally connected to Battery No. 1 by means of the SPU thermal strap (figure 1-33). Heat energy released in the Directional Gyro Unit (DGU) is stored in the DGU and Battery No. 2 by means of the DGU thermal strap. Space radiators are mounted on the top of the SPU, DCE, Battery 1 and Battery 2 (figure 1-34). Fused silica second surface mirrors are bonded to the radiators to minimize the solar energy absorbed by an exposed radiator, and to minimize the degradation of the radiating surface by the space and lunar environment. The space radiators are exposed only during the parking period between sorties. During sortie operation the space radiators are protected from the lunar surface dust by three dust covers (figure 1-31). The first dust cover protects the radiators on Battery No. 1 and the DCE. The second dust cover protects the SPU radiator. The third dust cover protects the radiator on Battery No. 2. These dust covers are opened manually at the end of the sortie, an over center latch (figure 1-35), holds the dust covers open until battery temperatures reach 45°F (+ 5°F), at which time a bimetallic device disengages the overcenter latch allowing the dust covers to close. The SPU dust cover is slaved to the Battery No. 1 dust cover.

In addition to the dust covers, a multi-layer insulation blanket (figure 1-36) is provided to protect the forward chassis components from the space environment and the lunar surface environment. The exterior, and certain portions of the interior, of the multi-layer insulation blanket are covered with a layer of Beta Cloth to protect against wear and tear and direct solar or hot gas heat loads.

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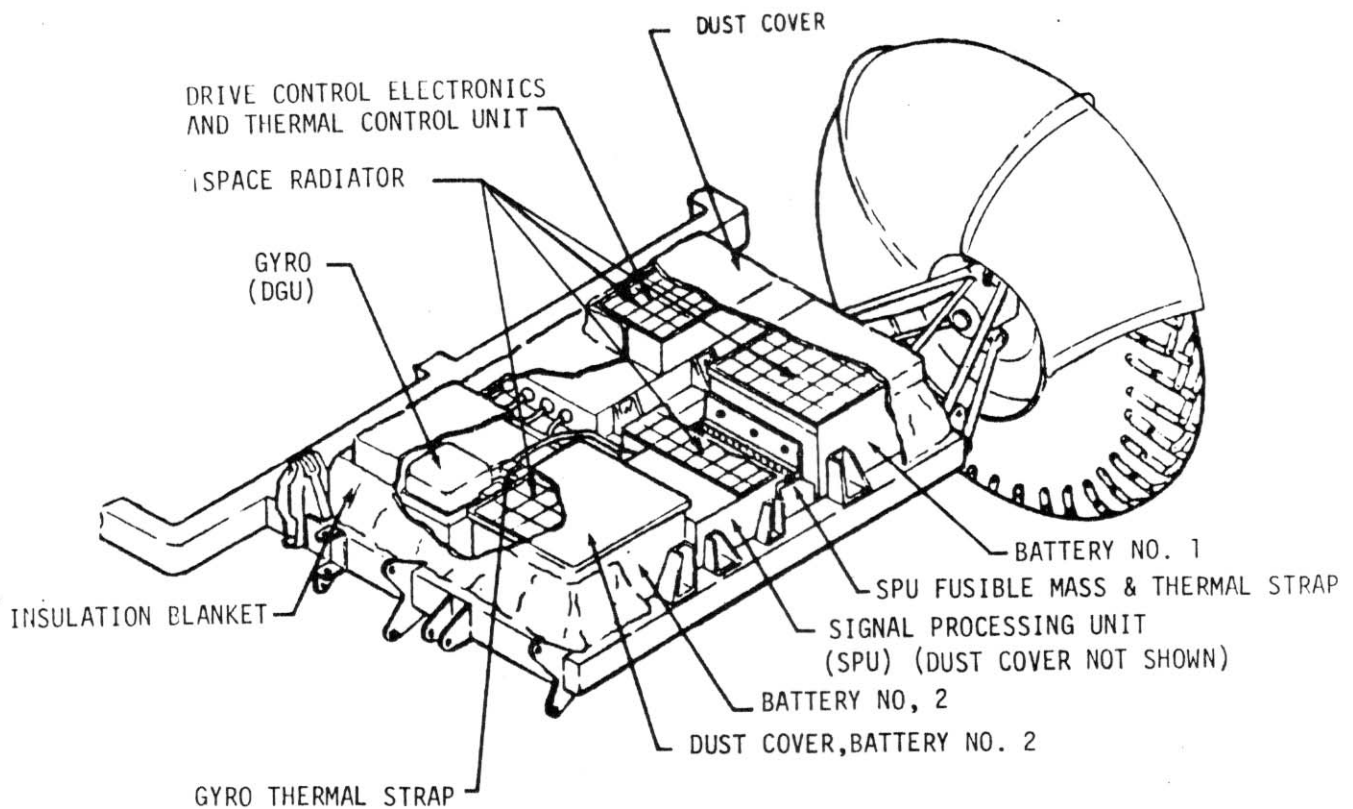


FIGURE 1-31 THERMAL CONTROL PROVISIONS (FORWARD CHASSIS)

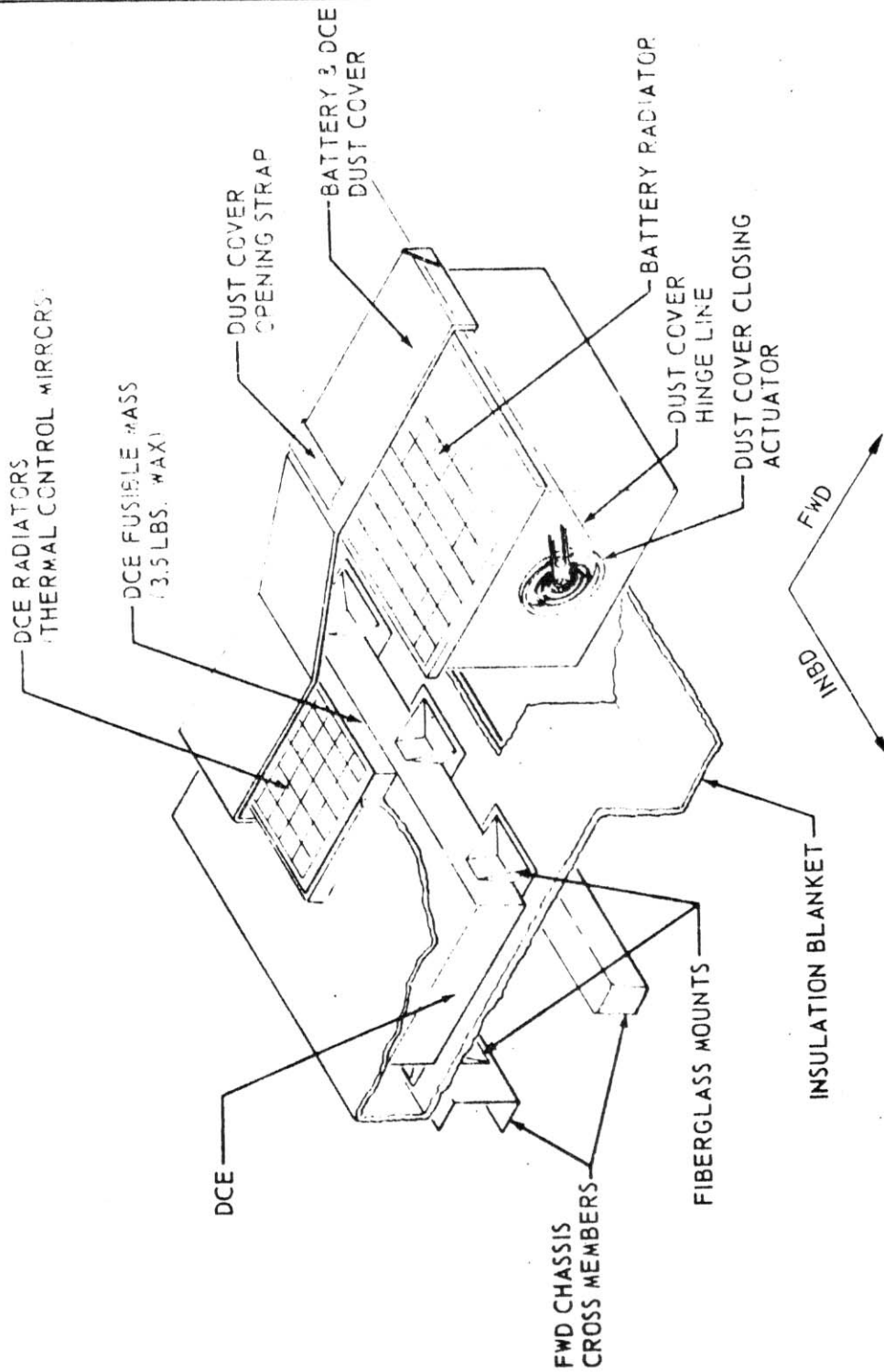


FIGURE 1-32 DRIVE CONTROLLER ELECTRONICS THERMAL CONTROL

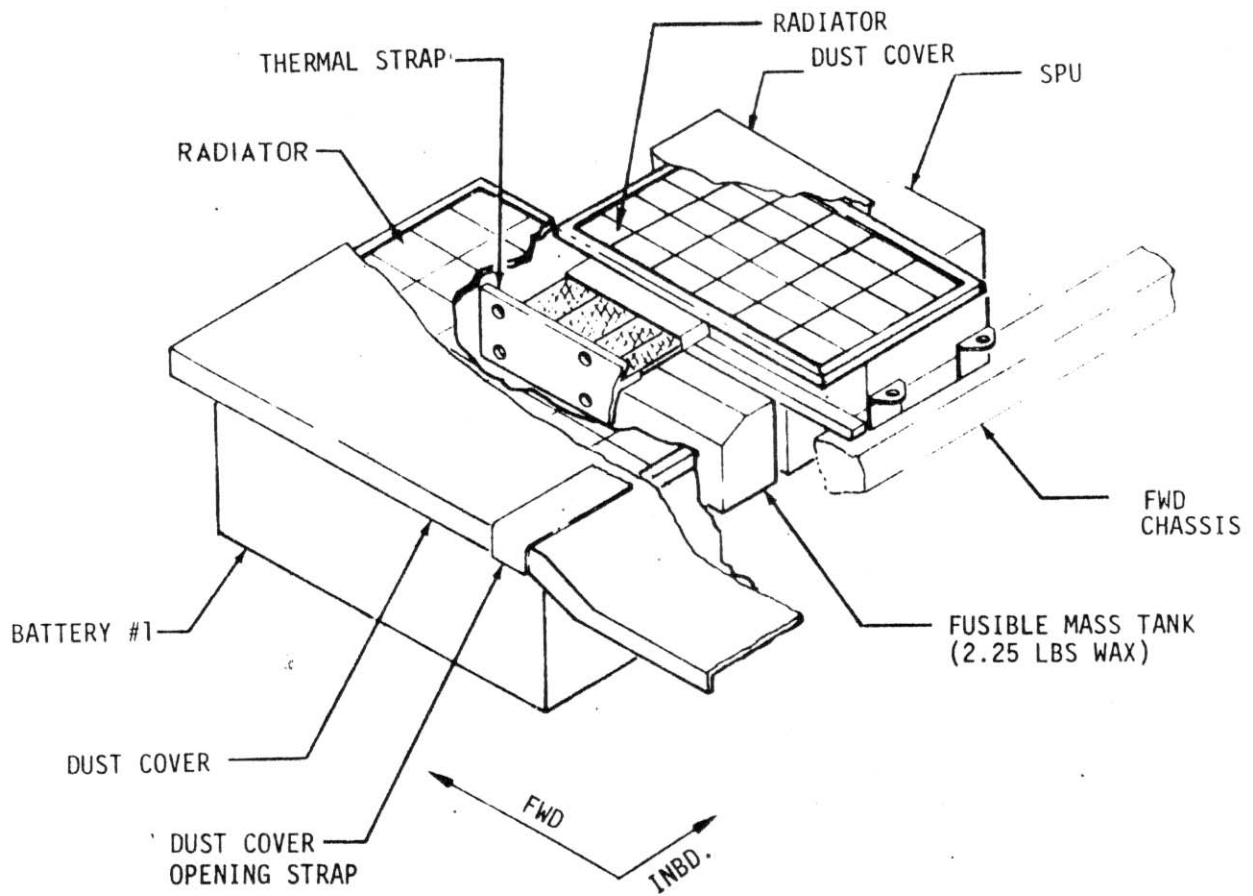


FIGURE 1-33 SPU ELECTRONICS AND BATTERY #1 THERMAL CONTROL

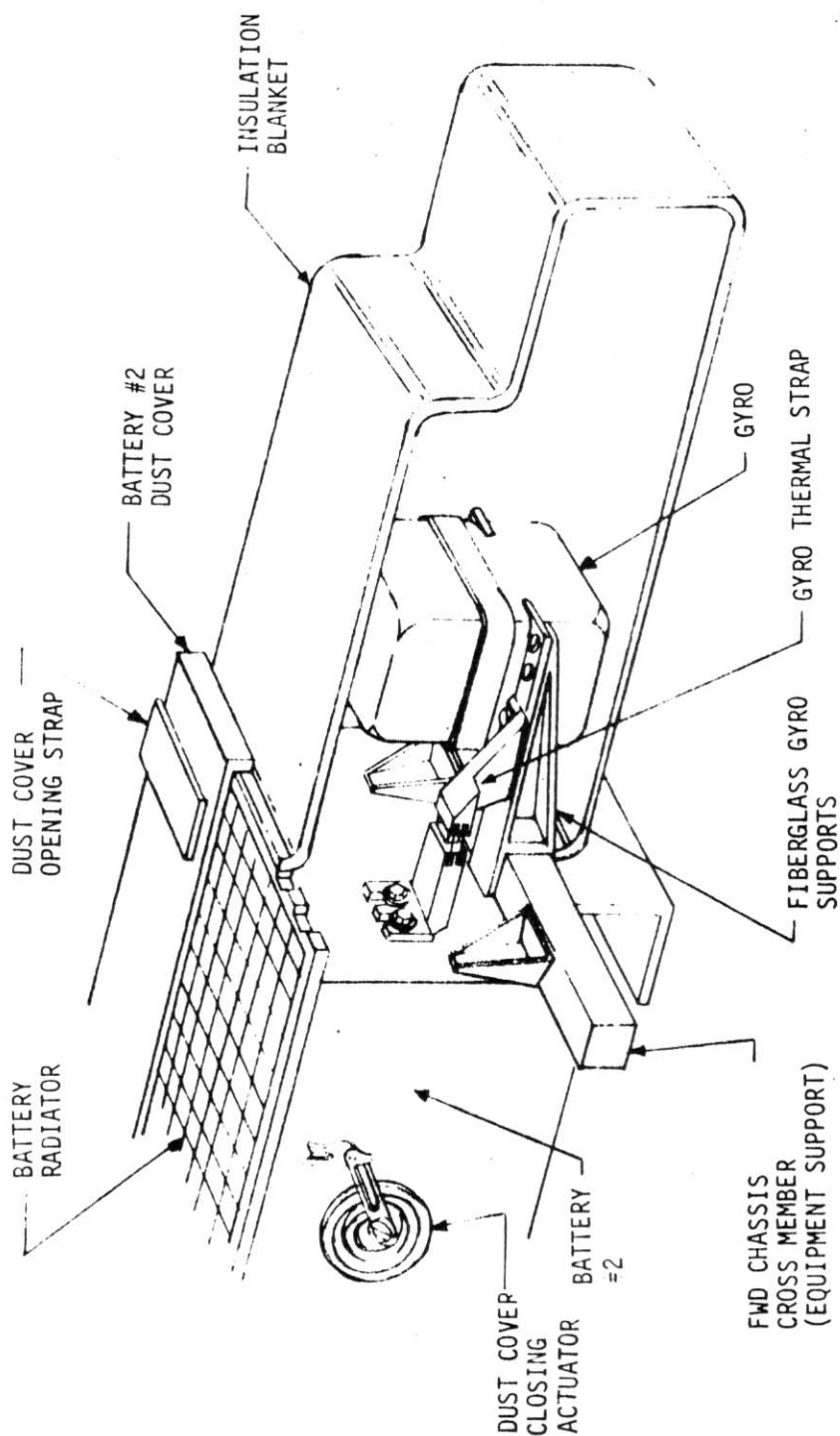


FIGURE 1-34 BATTERY NO. 2 AND DIRECTIONAL GYRO UNIT THERMAL CONTROL

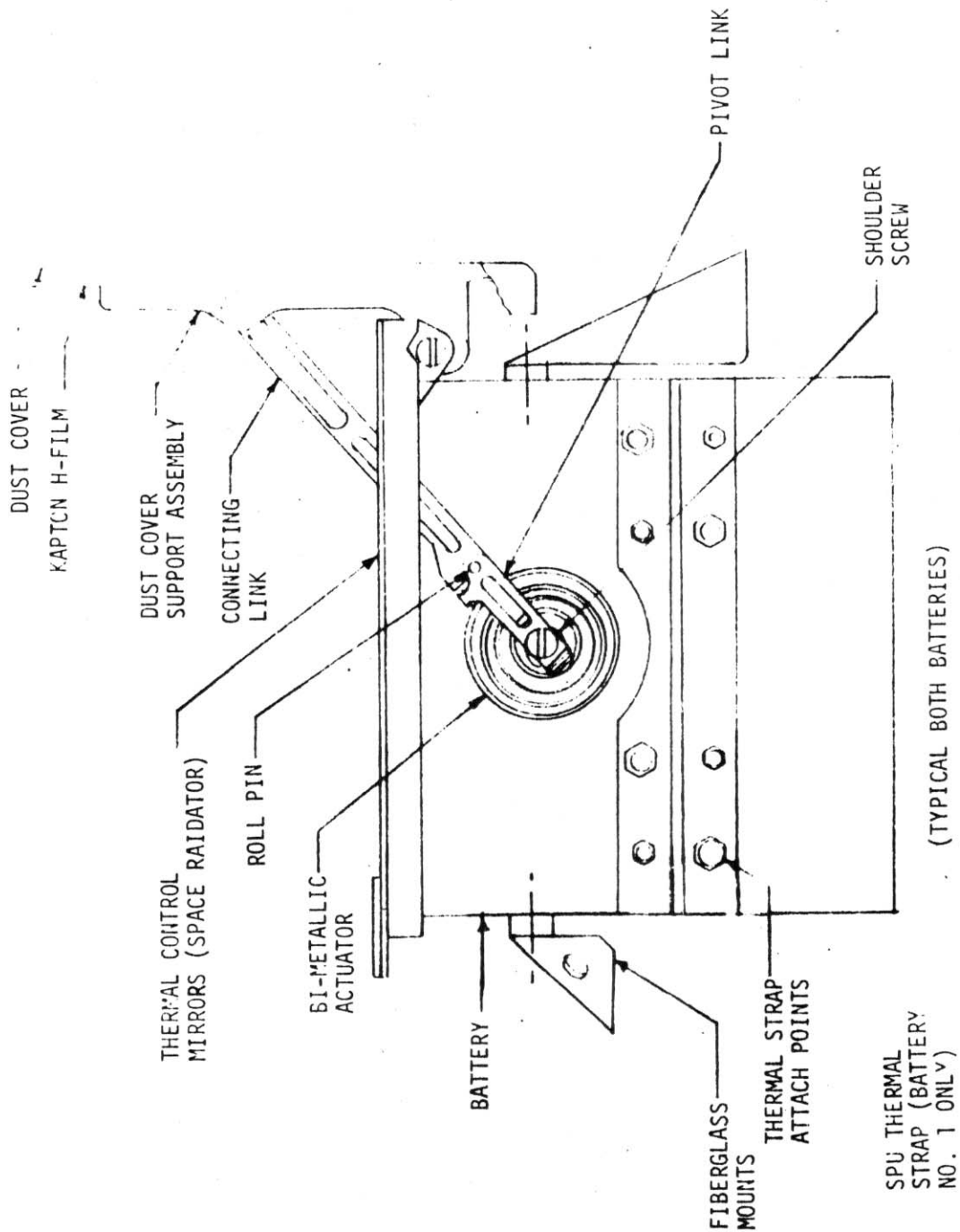


FIGURE 1-35 BATTERY DUST COVER CLOSING MECHANISM

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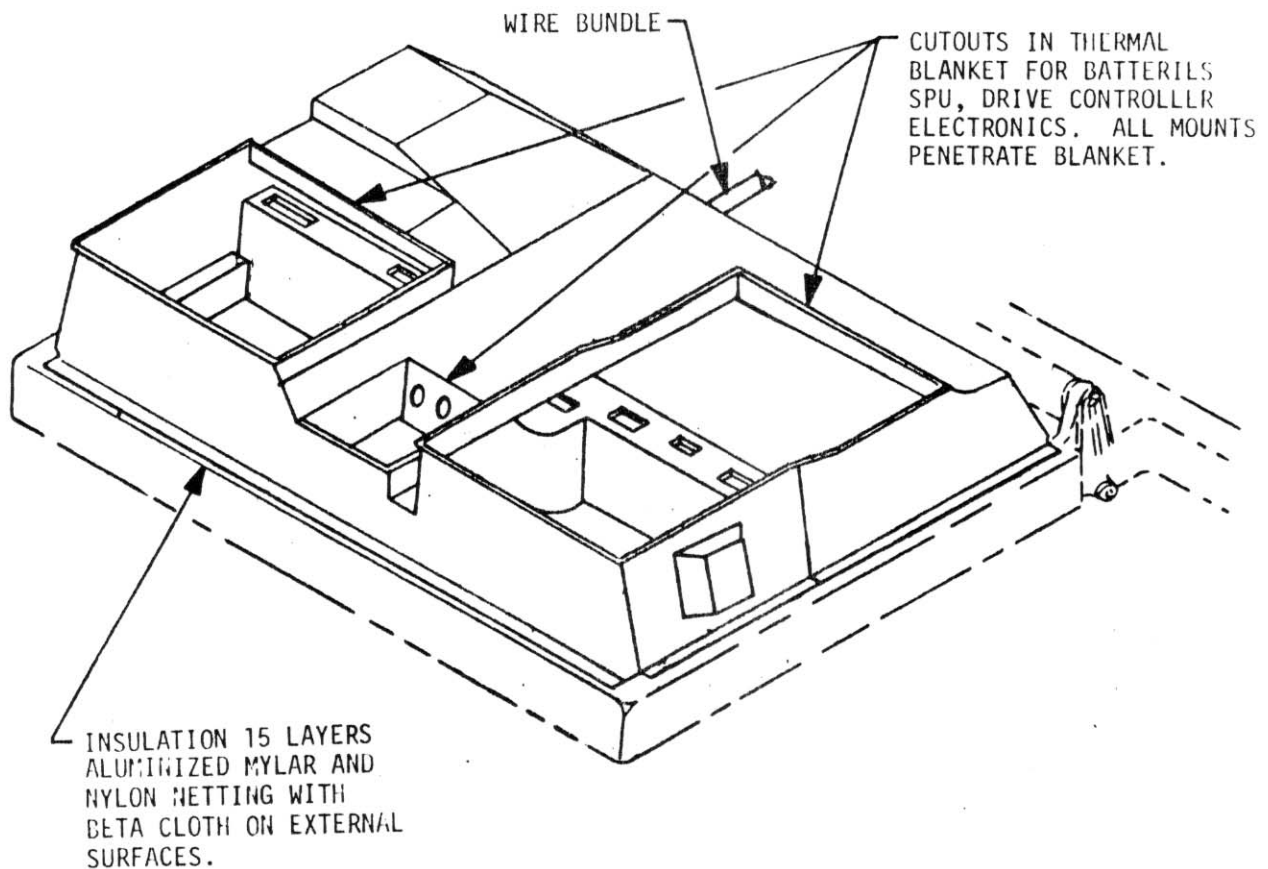


FIGURE 1-36 FORWARD CHASSIS INSULATION BLANKET

1.8.2 (Continued)

During a sortie, the astronauts can monitor the battery temperature by a meter on the Control and Display Console.

1.8.3 Control and Display Console

All instruments on the Control and Display Console are mounted to an aluminum plate which is isolated by radiation shields and fiberglass mounts. The external surfaces of the C&D console are coated with thermal control paint (Dow-Corning 92-007), and the face plate is black anodized and is isolated from the instrument mounting plate.

1.8.4 Center Chassis

Handholds, footrests, tubular sections of seats and center and aft floor panels are anodized.

1.8.5 1G Trainer Thermal Control

Whereas the LRV Flight Unit utilizes radiation to effect thermal control, the 1G Trainer relies primarily on convection to the atmospheric surroundings. The following 1G Trainer elements are cooled by a thermostatically controlled fan blower: traction drive (4 units) electronics assembly, battery (2 units), motor controller assembly (2 units), C&D console, DGU, and SPU. This makes a total of 12 separate blowers on the vehicle. Each fan motor thermostatic switch closes upon a rising temperature at a predetermined value, thereby applying battery voltage to a fan motor. When the temperature of the thermostat falls below a predetermined value, the switch opens, thereby shutting the fan motor off. Cooling fan motors and instrumentation warning thermostats are set as noted in Table 1-2.

NOTE

The forward wheel traction drive fan blowers are enabled provided that there is power through at least one forward drive power switch. Similarly, the rear wheel traction drive fan blowers are enabled provided there is power through at least one rear drive power switch.

In addition to protective cooling, thermal instrumentation display at the C&D is provided for the traction drives and batteries. The display takes the form either of a discrete warning by a warning flag (activated by a thermostat) or an analog temperature display, (as sensed by a thermistor). Warning flag thermostats are located on the external motor case of each traction drive motor, on the external case of each traction drive gear reducer, and within each battery assembly. Thermostats are set as noted in Table 1-2. Note that a warning flag activation can be generated in a traction drive assembly by

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<u>COOLING FAN MOTOR THERMOSTATS SET AT:</u>		
<u>Sub Assembly</u>	<u>Close On Rise Temp</u>	<u>Open On Fall Temp</u>
Traction Drive Motor (4 units)	160 \pm 10°F	140 \pm 10°F
Electronics Assembly (1 unit)	100 \pm 5°F	85 \pm 5°F
Battery (2 units)	100 \pm 5 °F	85 \pm 5°F
Motor Controller Assembly (2 units)	100 \pm 5°F	85 \pm 5°F
Display & Control Console (1 unit)	120 \pm 3°F	114 \pm 3°F
Navigation SPU	120 \pm 3°F	114 \pm 3°F
Navigation DGU	150 \pm 5°F	140 \pm 5°F

<u>WARNING FLAG THERMOSTATS SET AT:</u>		
<u>Sub Assembly</u>	<u>Close On Rise Temp</u>	<u>Open On Fall Temp</u>
Traction Drive Motor (4 units)	225 \pm 5°F	175 \pm 10°F
Traction Drive Gear Reducer (4 units)	200 \pm 5°F	150 \pm 10°F
Battery (2 units)	160 \pm 5°F	120 \pm 5°F

<u>ANALOG DISPLAY THERMISTORS RESISTANCE VALUES ARE:</u>		
Traction Drive Motor (4 units) Thermistor	3750 ohms \pm 10% @ 80°F	315 ohms \pm 20% @ 225°F
Battery (2 units) Thermistor	553 ohms \pm 5% @ 80°F	640 ohms \pm 5% @ 160°F

TABLE 1-2 1G TRAINER THERMAL CONTROL DEVICE SET POINTS

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1.8.5

(Continued)

either the drive motor or the gear reducer assembly. Since only the drive motor has its temperature displayed on the console meters, a condition could arise where a "hot" gear reducer activated the warning flag but none of the temperature indicating meters show an abnormally high temperature, i.e., the drive motor associated with the hot gear reducer has a normal temperature. Under this condition it would be impossible for the operator to isolate the over-temperature to a specific subassembly. To alleviate this condition, the gear reducer warning thermostat is connected through a circuit such that whenever it closes it switches a low resistance across the associated drive motor thermistor; thereby, causing an abnormally high temperature reading to be displayed. Thus, the affected traction drive assembly can be isolated.

Analog temperature thermistors are located on the external case of each drive motor and on the main battery bus within each battery. Thermistors located in each assembly are monitored by a bridge circuit in the D&C console and the output of the bridge drives the display meters, which are calibrated in degrees Fahrenheit. By interrogating the temperature display meters, an overtemperature condition can be isolated to the specific subassembly and corrective action initiated. The nominal resistance values associated with both an ambient temperature and a "hot" temperature for these thermistors is noted in Table 1-2. It should be noted that only the battery readout meter is calibrated to indicate the thermistor temperature. The drive motor meters are calibrated to read the internal motor (rotor) temperature even though the thermistor is located external on the motor case and hence at much cooler location. Thus, the meter indicated temperature for each motor will be 450°F to 500°F when the thermistor is measuring an actual case temperature of 225°F. The cooling fan motors will activate when the meter indicated temperature is nominally 350°F.

1.9 SPACE SUPPORT EQUIPMENT (SSE)

The Space Support Equipment (SSE) consists of two basic subsystems of hardware, the structural support subsystem and the deployment hardware subsystem. The function of the structural support subsystem is to structurally support the LRV in the LM during launch boost, earth-lunar transit and landing. The function of the deployment hardware subsystem is to deploy the LRV from the LM to the lunar surface after landing.

1.9.1 Structural Support Description

The structural support subsystem by which the LRV is attached to the LM includes two steel support spools at the lower (left and right) sides of the LM quadrant. The spools are bolted to Grumman Aircraft Corporation (GAC) attach fittings. Aluminum tube tripod structures attached to the LRV center chassis terminate in apex fittings which steel are pinned together and clamped to the spools to support the LRV. The LRV is restrained against outboard rotation by an aluminum strut in the upper center of the LM, connecting the inboard quadrant corner structure to an LRV center chassis standoff with a pin.

1.9.2 Deployment Hardware Description

The deployment hardware system (figure 1-37) consists of bellcranks, linkages and pins to release the LRV from the structural support subsystem, thus allowing the LRV to deploy from the LM. It also consists of braked reels, braked reel operating tapes, braked reel cables, LRV rotation initiating push-off spring, deployment cable, telescopic tubes, chassis latches, release pin mechanisms, and LRV rotation support points.

1.9.3 Deployment Mechanism Operations

The LRV is attached to the SSE and deployment mechanism and held in position in the LM Quadrant as shown in figure 1-38. The deployment of the LRV from the LM to the lunar surface consists of five basic steps or phases:

- Phase I - Deployment from the stowed position of both braked reel separating tapes and the deployment cable (figure 1-39, inset (A))
- Phase II - Operating the D-Handle to disconnect the LRV from the structural support subsystem (figure 1-39, inset (A)).
- Phase III - Operating the double braked reel to unfold the LRV and lower the aft chassis wheels to the lunar surface (figure 1-39, insets (B) (C) and (D)).

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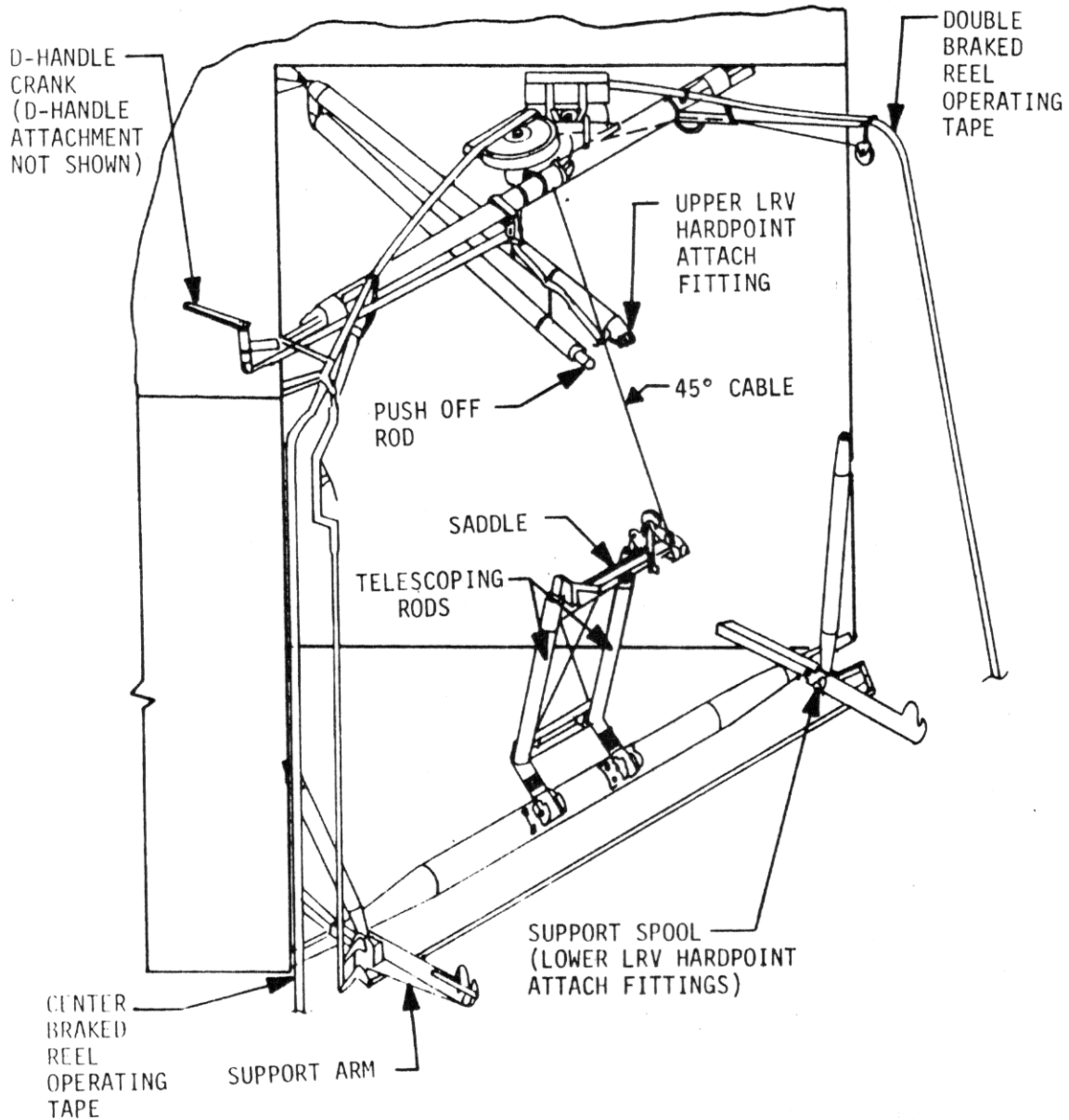


FIGURE 1-37 SPACE SUPPORT EQUIPMENT

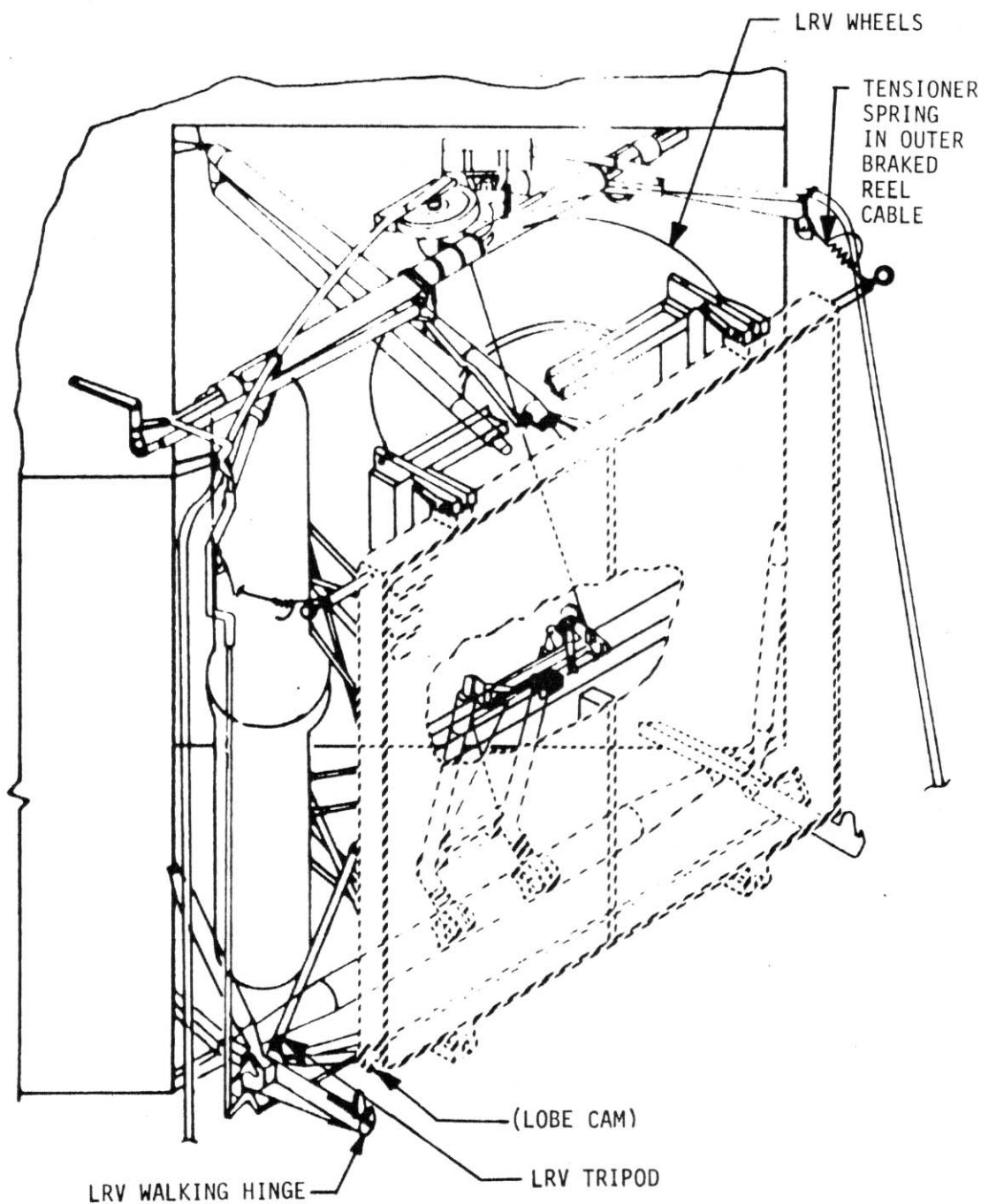


FIGURE 1-38 LM/SSE WITH LRV INSTALLED

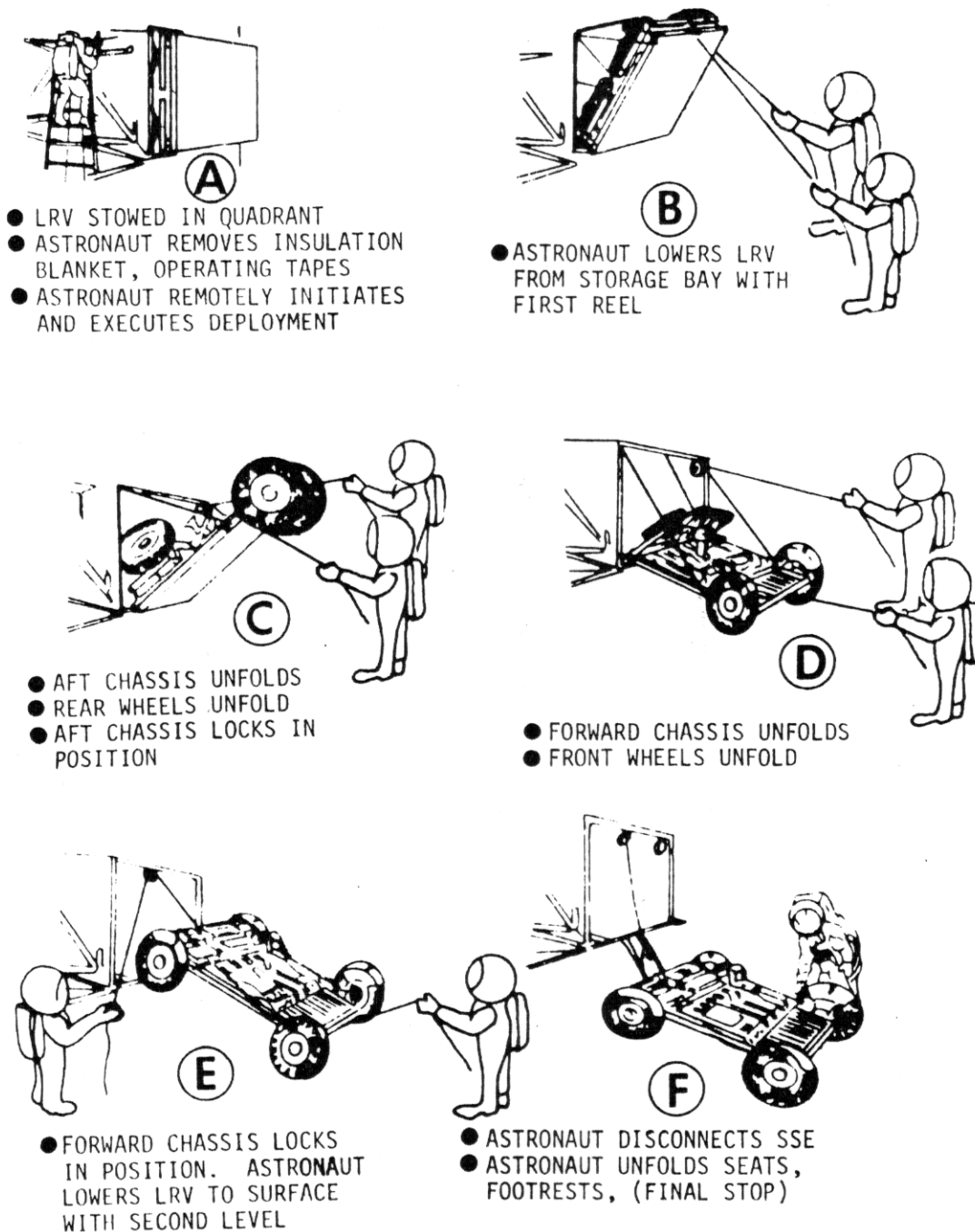


FIGURE 1-39 LRV DEPLOYMENT SEQUENCE

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1.9.3 (Continued)

- Phase IV - Operating the center braked reel to lower the forward chassis wheels to the lunar surface (figure 1-39, inset (E)).
- Phase V - Disconnecting the SSE from the LRV after all four wheels are on the surface (figure 1-39, inset (F)).

1.9.3.1 Phase I Deployment Description

This phase consists of visual inspection, removal of insulation blanket (figure 1-40), deployment of the two braked reel operating tapes and the deployment cable from their stowed position. The double braked reel operating tape is stowed in a nylon bag attached to the lower, right support arm by velcro tape. The center braked reel operating tape is stowed on the left side of the LRV center chassis by velcro tape in a nylon bag attached to the lower left support arm by velcro tape (figure 1-41). The deployment cable is stowed on the left side of the LRV center chassis by teflon clips. The deployment cable is used to assist deployment of the LRV in the eventuality that the LRV stops during any phase of the deployment.

1.9.3.2 Phase II Deployment Description

At the completion of Phase I, the astronaut actuates the D-handle, which is located on the right side of the porch (figure 1-42). The first 5 to 6 inches of travel of the D-handle removes the two lower release pins (figure 1-43) out of the apex fittings, releasing the lower half of the apex fittings, allowing it to fall away immediately or during deployment rotation. The apex fittings are now configured to lift off of the spools when required. The last segment of travel of the D-handle removes the upper release pin. When the upper release pin is removed, the push-off spring rotates the LRV out from the LM approximately 4°, taking up the slack in the outer braked reel cables. The slack is due to cable tensioner springs in the cables.

1.9.3.3 Phase III Deployment Description

The LRV is now released from the LM and is ready to be deployed to the lunar surface. During the entire Phase III operations, the astronaut operates the double braked reel operating tape. The braked reel (figure 1-44) is a worm and worm gear arrangement. When the operating tape is pulled, the cable storage drum is rotated, thus releasing (feeding off) cable from the drum. The cable is attached to the LRV center chassis and, as the LRV rotates out-board due to gravity, supports the LRV. As the drum is rotated, feeding out cable, the LRV is allowed to rotate and deploy. For the first 15° of rotation, the LRV rotates on the apex fittings. At 15° rotation, the walking hinge is engaged by the LRV and the point of rotation shifts from the apex fittings to the walking hinge, at which point the apex fitting lifts off of the spools. The deployment cable may or may not be required at this time, depending on the landed attitude of the LM.

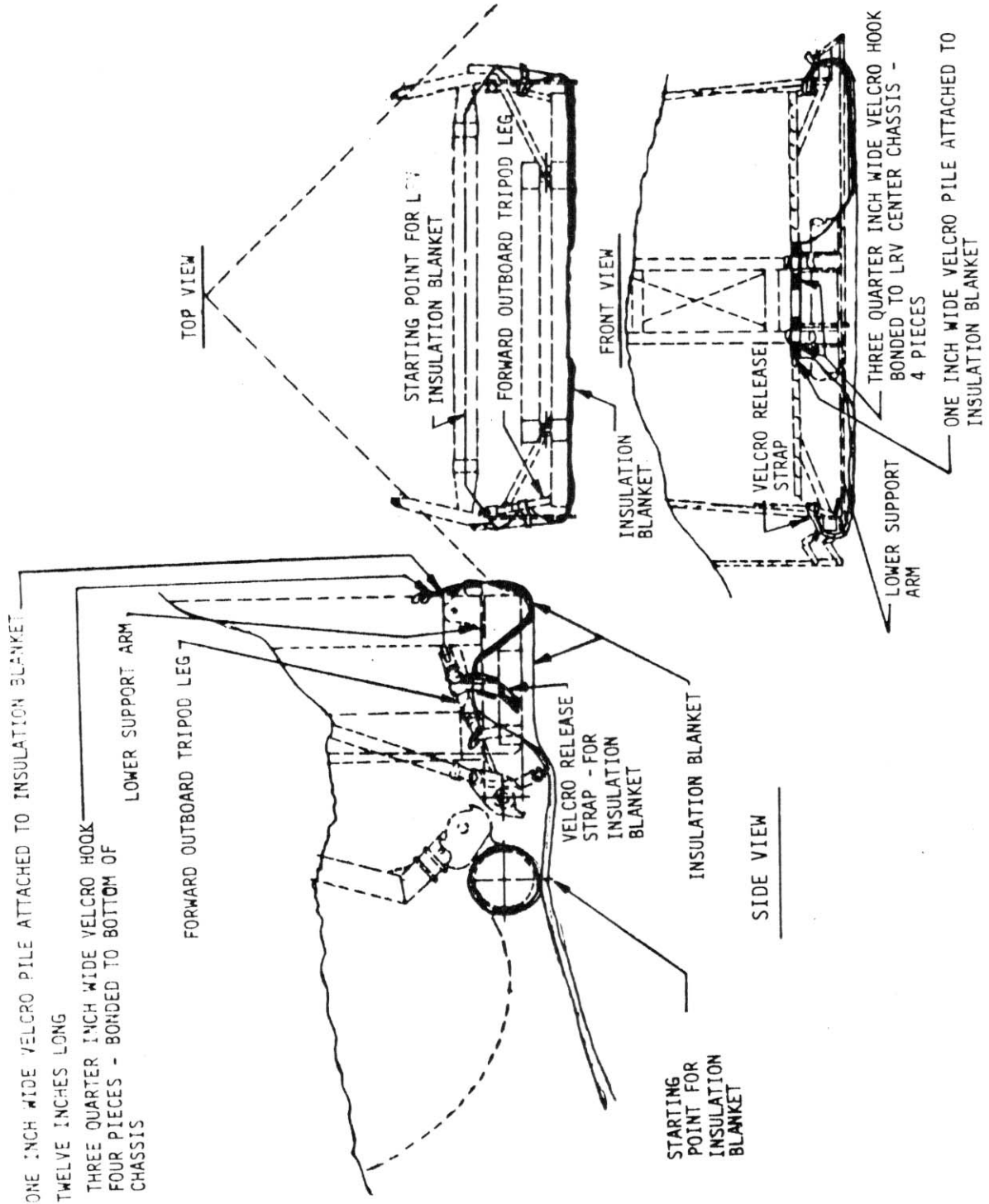


FIGURE 1-4C INSULATION BLANKET

NOTE: DOUBLE BRAKED REEL
DEPLOYMENT TAPE SIMILAR
TO CENTER BRAKED REEL
TAPE BUT STOWED ON
RIGHT SIDE OF VEHICLE

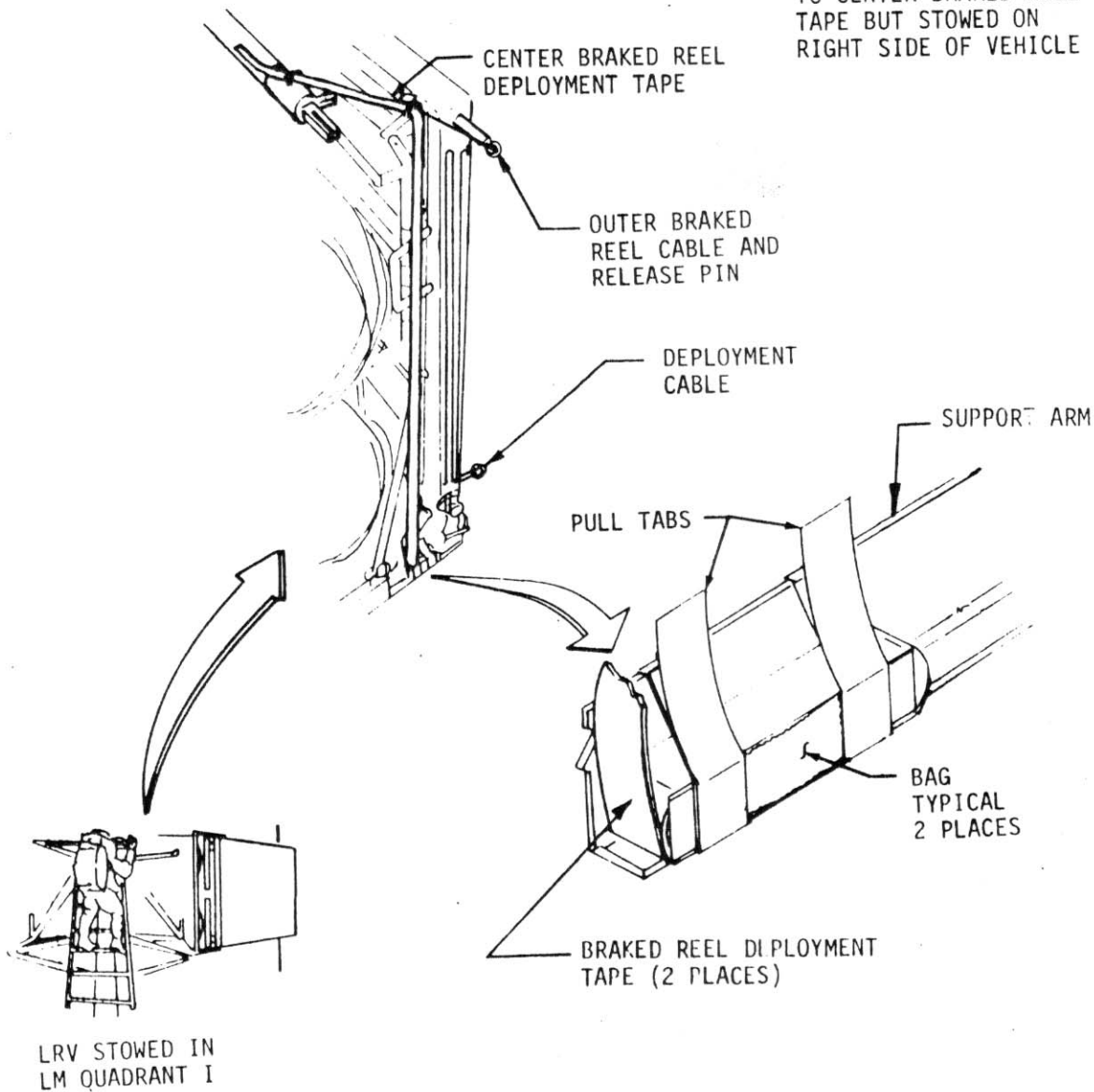


FIGURE 1-41 LRV DEPLOYMENT TAPES AND CABLES

This diagram illustrates the mechanical system for releasing the D-handle from the LM (Lunar Module) and attaching it to the GAC (Ground-to-Air Cable). The components shown include:

- D HANDLE**: The handle to be released.
- PIP-PIN (INSTALLED)**: A pin used to secure the handle.
- RETAINER**: A component that holds the PIP-PIN in place.
- LOCK-CABLE**: A cable used to lock the handle.
- DEPLOYMENT CABLE**: A cable used to deploy the handle.
- D HANDLE RETAINER**: A component that holds the D-handle in place.
- PIP PIN**: A pin used to secure the D-handle.
- PORCH**: A platform where the D-handle is initially located.
- PULLEY**: A wheel that guides the cable.
- BOEING GAC INTERFACE**: The connection point for the Ground-to-Air Cable.
- D-HANDLE BELL CRANK**: A lever that changes the direction of the cable's pull.
- LM**: The Lunar Module, shown as the base structure.

The diagram shows the D-handle being moved from its initial position on the porch, through the retainer and lock cable, and finally being released from the LM structure via the deployment cable and bell crank mechanism.

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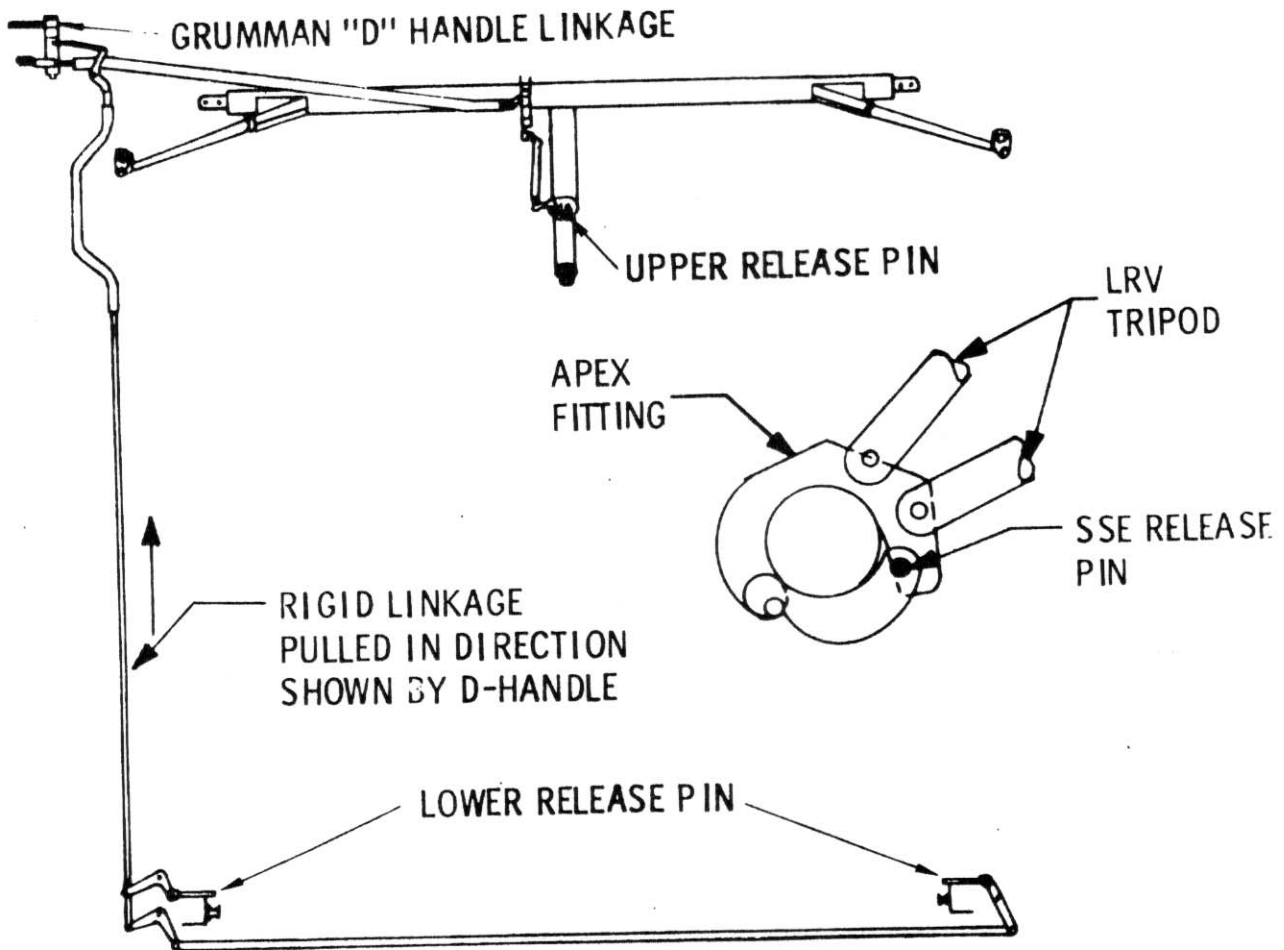


FIGURE 1-43 LRV/SSL SUPPORT STRUCTURE AND RELEASE SYSTEM

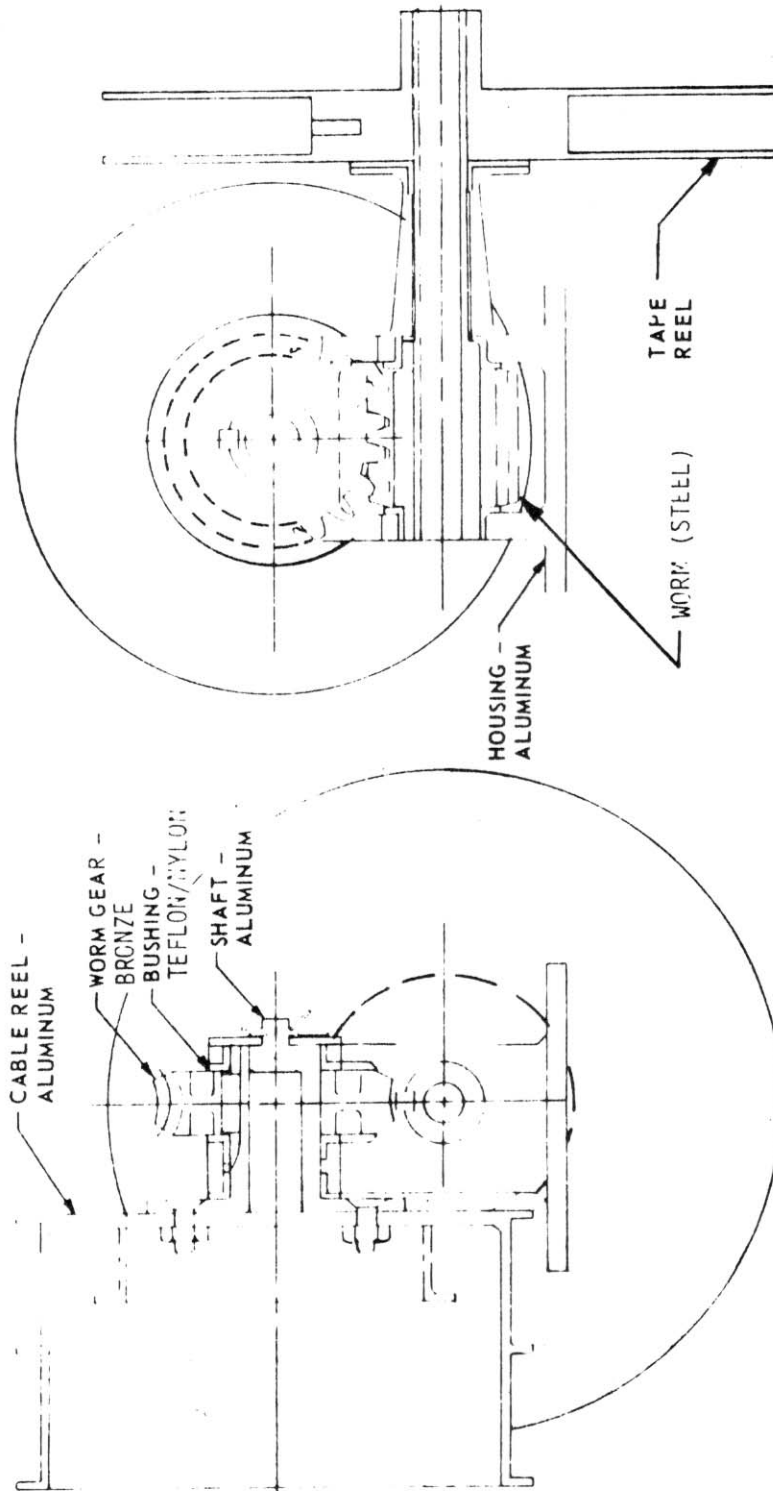


FIGURE 1-44 BRAKED REEL

1.9.3.3 (Continued)

The LRV continues to rotate about the walking hinge. At 35° rotation, the lower telescopic tubes ratchets are engaged, preventing any reverse rotation of the telescopic tube assembly about its lower pivot points. The telescopic tube assembly consists of a pair of three telescoped aluminum tubes, hinged to the GAC structure (lower center of the LM quadrant) and connected at the top by the saddle (figure 1-44). The aluminum saddle fits to the forward section of the forward chassis, held by two dowel pins and a ball-lock pin clevis joint. The saddle carries the pulleys, cables and pin mechanisms whereby the forward and aft LRV chassis are unlocked from the stowed (folded) LRV position. As the LRV moves outboard, the 45° cable tightens, and rotates each with a steel cable and ball-lock pin. The two ball-lock pins lock the connection between forward and aft chassis to the console post mounted on the center chassis (figure 1-45). If either the aft chassis latch pins or the forward chassis latch pin fails to pull, the deployment cable may be pulled to accomplish this action. (The mechanical advantage of the deployment cable to the pins themselves is 5 to 1).

The telescopic tubes and forward chassis stops at 45° due to the 45° cable (chassis latch actuating cable) becoming taut, then by counteracting forces of the LRV forward chassis hinge torsion spring, the telescopic tubes and forward chassis return to the 35° position (stop due to the telescopic tube ratchet). The center chassis and aft chassis continue to deploy. After it is unlocked, the aft chassis fully deploys (unfolds) due to the aft chassis hinge torque bars, until it latches with the center chassis.

The wire mesh LRV wheels are held in the stowed position by four aluminum tube struts. One end of each strut is held by a steel pin to the aft or forward chassis structure (figure 1-46). The other end of each strut is held to a wheel hub by a pin (in the hub). The pins in the chassis are pulled by a steel cable, so linked as to pull the pins as the chassis opens, approximately 170°. When the pins are pulled, the spring-loaded wheels move to deployed or operational position. As the wheels rotate forward to the deployed position, a mechanism within the wheel hub retracts the remaining pin retaining the wheel strut. The strut is thus freed at both ends, and falls free during wheel deployment movement. Each strut is retained by a 1/8 inch diameter mylar tether.

The LRV center/aft chassis continues outboard rotation, pivoting around the lower support arm latch. During LRV outboard rotation, the telescopic tubes extend (lengthen). Before 72° LRV rotation an anti-collapse telescopic tube latch in each tube engages to prevent shortening (but permit elongation) of the tubes.

At approximately 73° center chassis angle, the lobe (cam) on the forward sides of the center chassis strut (engaged in the lower support arm latch) strikes the steel latch lock arm. As the chassis rotates, the cam forces the latch lock arm down out of a safety retaining spring, and unlocks the latch. The center/aft chassis continues to rotate until the aft chassis wheels

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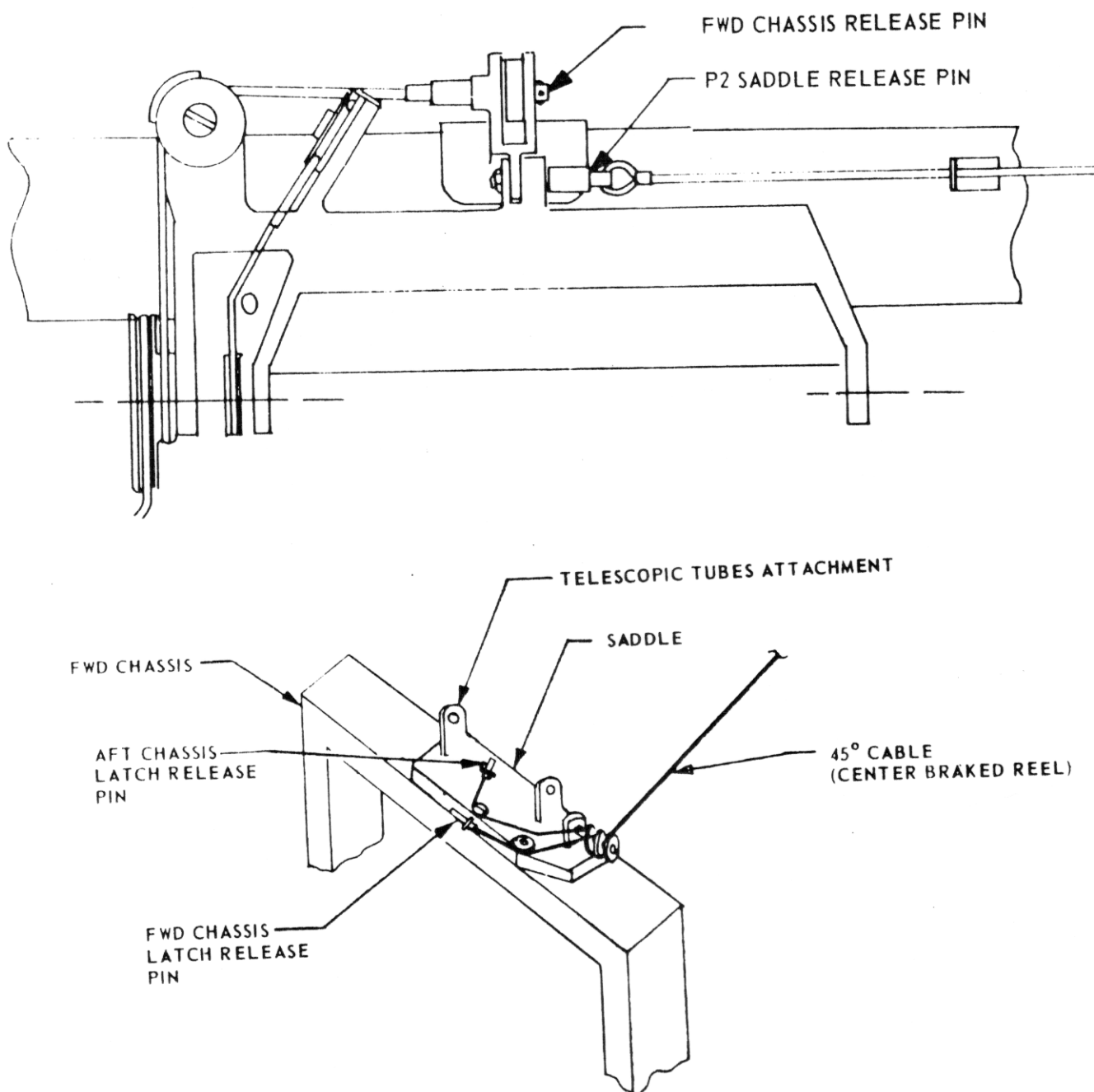


FIGURE 1-45 LRV SADDLE AND FORWARD CHASSIS LATCH RELEASE

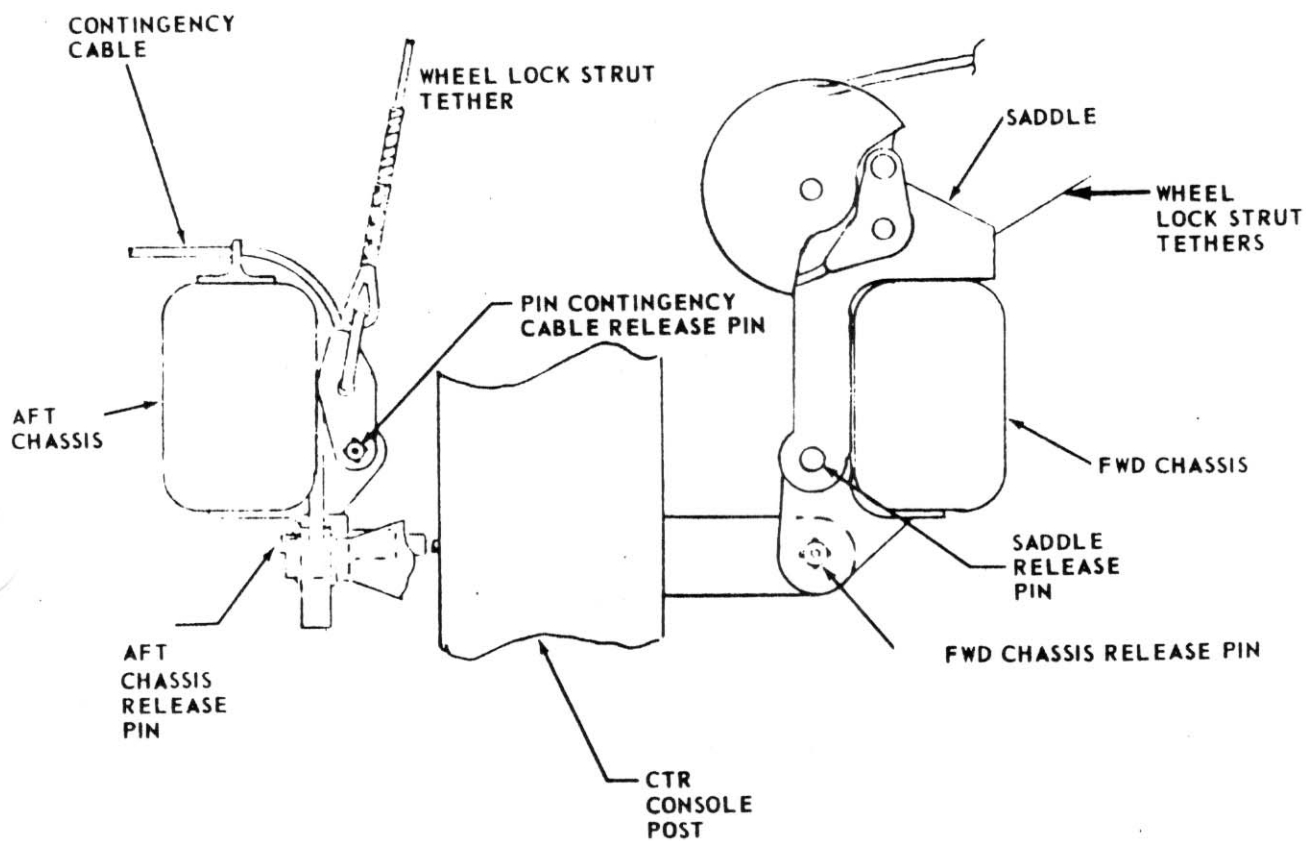


FIGURE 1-46 FORWARD AND REAR CHASSIS LATCH

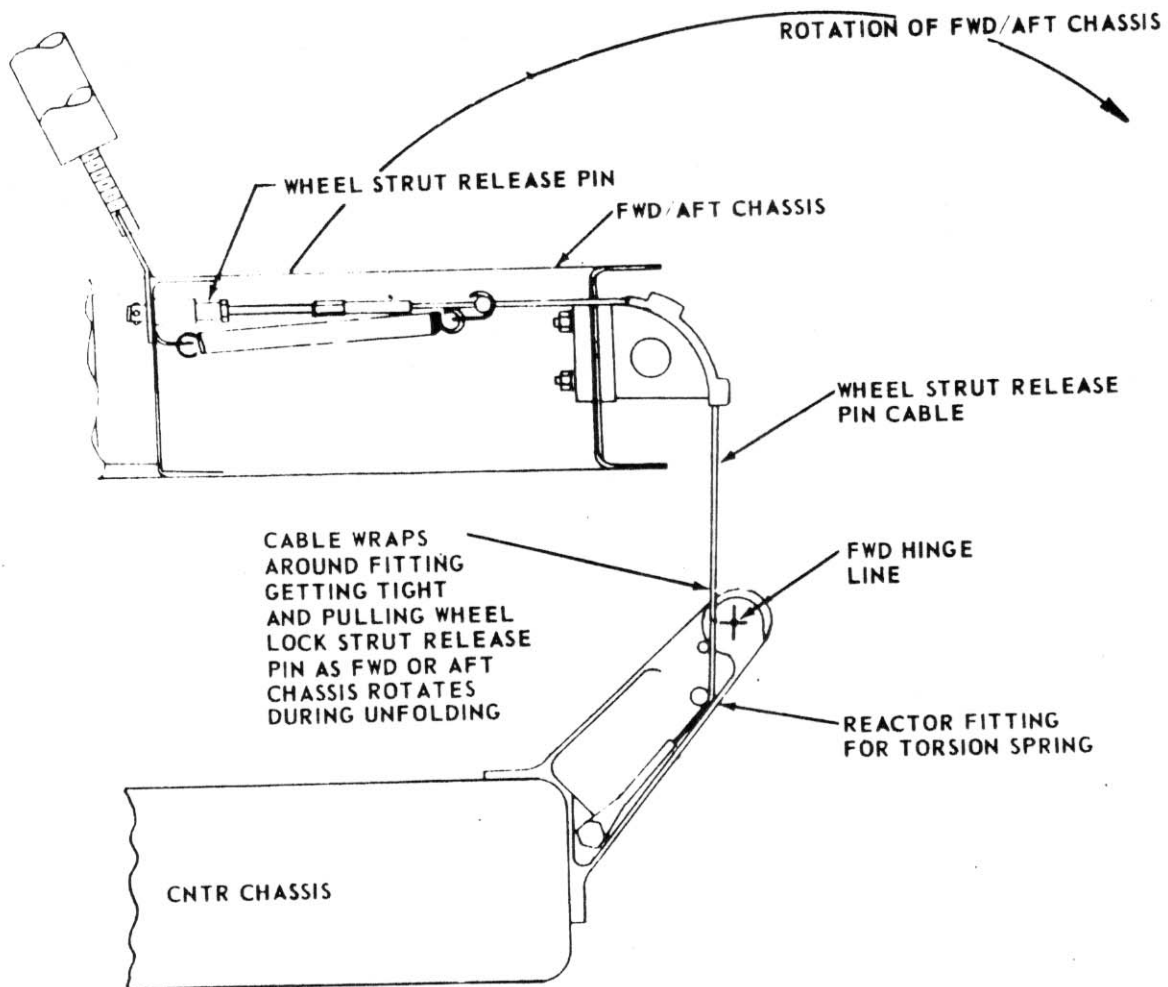


FIGURE 1-47 WHEEL LOCK STRUT RELEASE

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1.9.3.3 (Continued)

are on the surface. The wheels are locked with the emergency hand brake, therefore must slide on the surface. Depending on the landing attitude of the LM and the condition of the surface, the wheels might not slide on the lunar surface, therefore use of the deployment cable by the astronaut would be required. The astronaut continues to actuate the double braked reel operating cable to allow the forward chassis hinge to deploy by virtue of the forward chassis hinge torsion spring. Concurrently, the center/aft chassis move outboard, away from the LM. At this point in the sequence, the 45° cable becomes taut due to the outboard movement of the entire LRV. The center chassis continues to move down and, driven by the forward chassis springs, outboard. As the angle between forward and center chassis approaches 170°, the forward wheel lock strut pins in the forward chassis release, and the forward wheels deploy like the previously described aft wheel deployment. The astronaut then pulls the pins that attach the two outer braked reel cables to the center chassis.

Phase III is complete (motion ceases) with the aft wheels on the lunar surface, with forward and aft chassis locked to the center chassis, all wheels deployed, all four wheel struts free and hanging from their tethers, the outer braked reel cables released, and with the forward chassis held up by the telescopic tube assembly and the 45° cable.

1.9.3.4 Phase IV Deployment Description

This phase of the deployment consists of the astronaut actuating the center braked reel operating tape, thus allowing the forward chassis to lower and the forward chassis wheels to lower to the surface. Again, the deployment cable may be required at this point if the aft wheels will not slide on the surface.

1.9.3.5 Phase V Deployment Description

This phase consists of releasing the deployment hardware from the LRV. The astronaut pulls up on the saddle release cable, located on the left rear side of the forward chassis. This operation releases a ball-lock pin which holds the saddle on the forward chassis. When the saddle is released, the following hardware goes with it:

- a. Telescopic tube assembly.
- b. Forward and aft chassis lock release pins.
- c. Forward chassis wheel lock struts and tethers.

The astronaut then pulls a ball lock pin, located on the aft center of the aft chassis. This releases the deployment cable and the aft chassis wheel lock struts. At this point, the deployment from the LM to the lunar surface is complete.

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SECTION 2
NORMAL PROCEDURES

INTRODUCTION

This section defines the normal procedures to be followed by the astronauts for operating the LRV on the lunar surface and the 1G Trainer during earth training operations.

*** 1G TRAINER NOTE ***

The procedures contained in this section also apply to 1G Trainer operation with the exception of deployment operations, defined in 2.1. When performing training per paragraph 2.1 all steps can be performed except those dealing with pulling the LM D-rings, inspecting hinge pins, and deploying the inboard handholds.

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STA/STEP	PROCEDURE	REMARKS
2.1	UNLOADING AND CHASSIS DEPLOYMENT	
	Both crewmen are utilized. Procedure steps are for one crewman unless otherwise noted.	Prior to initiation of the subsequent procedures, crew should position TV camera to monitor all LRV deployment operations.
	a. Perform an overall inspection of the LRV and SSE to verify proper configuration and no obvious damage.	To extent which lighting and landing angle permits inspect lower tube and bell crank assemblies, left side tube assembly, and upper tube and bell crank assemblies and verify there are no obstructions preventing the operation of these pin release mechanisms.
	b. Release LRV insulation blanket.	Perform overall inspection of those portions of LRV and SSE which were previously obscured by the insulation blanket.
	c. Inspect each of two lower support arm latches to verify proper configuration. Latch should be in position and trip arm should be up. Apply force to latch to verify support.	Figure 2-1.
	If either latch is in the "tripped" position, reset as follows: (1) Push trip arm down. (2) Rotate latch up into position. (3) Raise trip arm until locking dog on trip arm engages the receptacle on the latch.	Figure 2-2.
	d. Release center braked reel deployment tape stowed in nylon bag attached to lower left support arm by velcro tape.	
	e. Stow braked reel deployment tape by draping it over a LM landing strut for convenient future access.	Tape should be placed so that crewman is not required to move